PRODUCTION ENGINEERING LABORATORY — SECTION 5

Subsurface Production Tools

Restoration, Function, and Field Reference

Restored tools — Production Engineering Laboratory, DUIET

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1. Introduction

This document covers the subsurface (downhole) production tools restored as part of the Production Engineering Laboratory development exercise — the completion-string hardware that controls flow, pressure, and isolation within the wellbore below surface. This section connects directly to the author's M.Tech thesis topic, continuous gas lift design for vertical oil wells, since the gas lift valve and mandrel covered here are central components of that system.

2. Tubing

Production tubing is the string run inside the casing through which reservoir fluids are produced to surface.

2.1 Design Considerations

- Tubing size is selected based on expected flow rates, balancing frictional pressure loss against erosional velocity limits.
- Smaller tubing increases gas-liquid mixture velocity, which can help unload liquids in lower-rate wells but increases friction losses at higher rates.
- Tubing size is a key input to artificial lift design, including the gas lift design work forming the author's thesis.

2.2 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Production packer setting animation — search (YouTube)

Reference: SLB Energy Glossary

3. Packer (Mechanical & Hydraulic)

A packer is a downhole sealing device that isolates the tubing-casing annulus at a chosen depth, anchoring the tubing string and preventing fluid communication between zones above and below the packer.

3.1 Mechanical Packer

A mechanical packer is set by manipulating the tubing string at surface — typically a combination of applied weight (slacking off) and rotation — which actuates a setting mechanism inside the packer to expand its rubber sealing elements and slips against the casing wall.

3.2 Hydraulic Packer

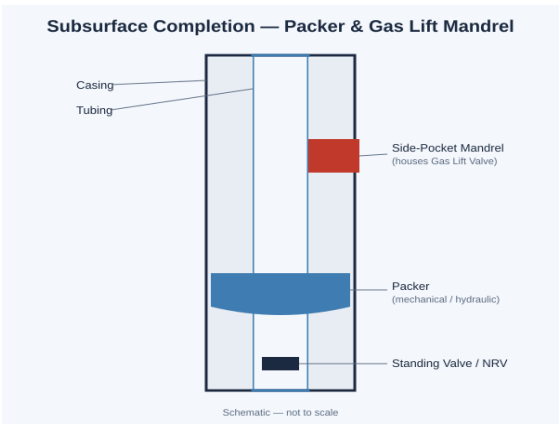
A hydraulic packer is set by applying fluid pressure down the tubing or annulus, which drives a piston inside the packer to compress and expand the sealing elements against the casing without needing string manipulation at surface — useful in deviated or horizontal wells where rotation/weight transfer to the packer can be unreliable.

3.3 Why It Matters

- Protects casing from exposure to produced-fluid pressure and corrosive fluids above the packer.
- Allows selective production or stimulation of a specific zone while isolating others.
- Anchors the tubing string against movement caused by pressure and temperature changes during production.

3.4 Restored Tool — Photograph & Schematic

Packer (Mechanical & Hydraulic), restored



Packer position in tubing-casing annulus

3.5 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Production packer setting animation — search (YouTube)

Reference: SLB (Schlumberger) — oilfield equipment reference

4. GLV (Gas Lift Valve)

A gas lift valve is a pressure-operated check valve installed in a side-pocket mandrel along the tubing string. It is the core control element of a continuous (or intermittent) gas lift system.

4.1 Working Principle

High-pressure gas injected down the tubing-casing annulus reaches the gas lift valve. When annulus pressure at the valve depth exceeds the valve's preset opening pressure (set by a charged nitrogen dome or spring), the valve opens and injects gas into the tubing. This injected gas reduces the effective density of the fluid column inside the tubing above the valve, lowering the hydrostatic pressure the reservoir must overcome and allowing the well to lift fluids to surface even after natural flow has declined.

4.2 Relevance to Thesis Work

Correct gas lift valve spacing, setting depths, and injection-pressure design are the central engineering problem in continuous gas lift design for vertical oil wells — the subject of the author's M.Tech thesis under Dr. Nayan Medhi. The valves and mandrel restored here provide a hands-on physical reference for that design work.

4.3 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Gas lift valve working animation — search (YouTube)

Reference: SLB (Schlumberger) — oilfield equipment reference

5. Mandrel (Side-Pocket Mandrel)

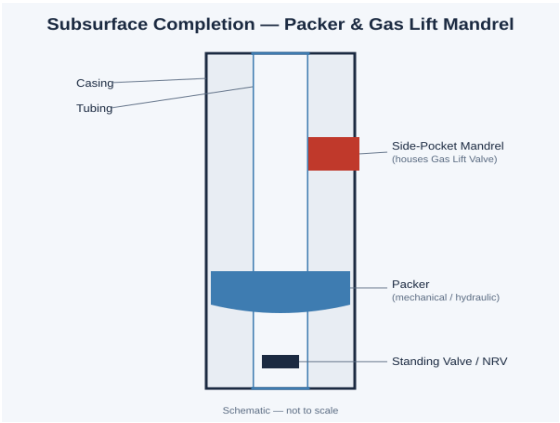
A side-pocket mandrel is a specially profiled joint of tubing that houses a removable gas lift valve (or other flow-control device) in an offset pocket alongside the main tubing bore.

5.1 Working Principle

The offset pocket design means the gas lift valve can be installed into or retrieved from the mandrel by slickline or wireline, without pulling the entire tubing string out of the well — a major operational and cost advantage, since changing a single valve setting no longer requires a full workover.

5.2 Restored Tools — Photograph & Schematic

Subsurface completion hardware, restored (for context)



Side-pocket mandrel & gas lift valve position

5.3 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

[Video: Side-pocket mandrel gas lift — search (YouTube)]

[Reference: SLB (Schlumberger) — oilfield equipment reference]

6. Standing Valve

A standing valve is a one-way check valve landed in a profile nipple within the tubing string.

6.1 Working Principle

The standing valve allows flow upward through the tubing but blocks flow downward. It is typically run and retrieved by slickline into a pre-installed nipple at a chosen depth.

6.2 Common Uses

- Holding pressure below it while pressure-testing the tubing string from surface.
- Isolating the lower completion while setting plugs or performing intervention work above.
- Forming part of certain artificial-lift configurations, including some gas lift well designs.

6.3 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Standing valve tubing completion — search (YouTube)

Reference: SLB (Schlumberger) — oilfield equipment reference

7. Downhole NRV

The downhole non-return valve performs the same one-way flow function as its surface counterpart (see Section 5, Surface Production Tools), but is run as a permanent or semi-permanent part of the completion string.

7.1 Why It Matters

By preventing backflow within the tubing under downhole conditions, the downhole NRV protects artificial-lift equipment, helps maintain lift efficiency in gas lift and other systems, and can prevent unwanted fluid fallback when the well is shut in.

8. Summary Table

Tool	Primary Function	Set/Run By
Tubing	Conduit for produced fluids to surface	Run with completion string
Packer	Isolates tubing-casing annulus	Weight/rotation or hydraulic pressure
Gas Lift Valve	Injects gas to lighten fluid column	Wireline, into side-pocket mandrel
Mandrel	Houses retrievable gas lift valve	Made up in tubing string
Standing Valve	One-way valve, holds pressure below	Slickline, into nipple profile
Downhole NRV	Prevents tubing backflow downhole	Run as part of completion string

This concludes Section 5 of the Production Engineering Laboratory tool reference series.